Coastal modelling topography data by waterline retrieval from Sentinel-1 satellite acquisitions: from method development to a Near Real Time service

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Summary

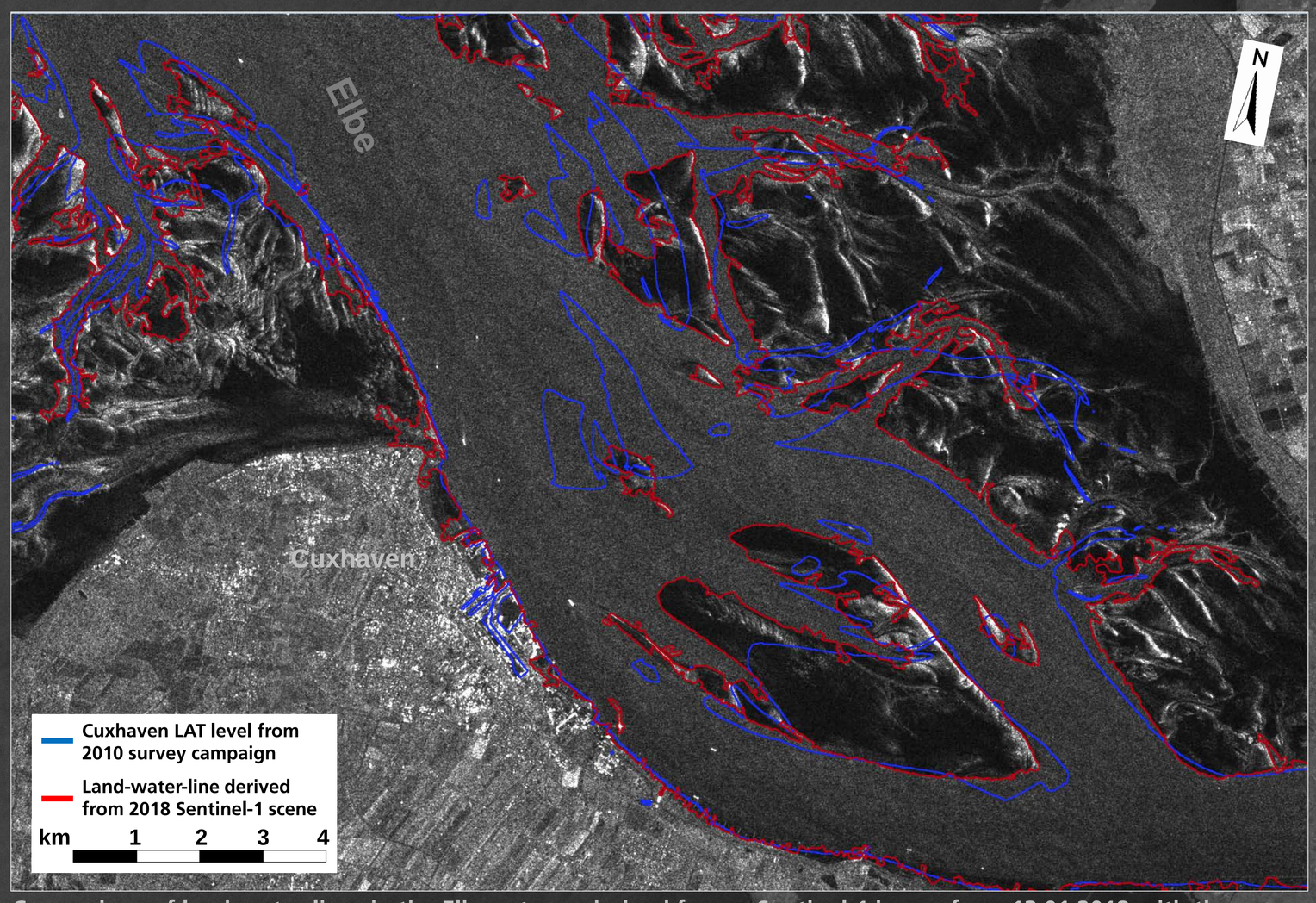
- Synthetic Aperture Radar (SAR) data are independent of cloud cover and lighting
- Sentinel-1 SAR satellites offer daily acquisitions available free of charge
- Developing automated waterline retrieval processor for coastal waters
- Special application for Wadden Sea: Tidal flats topography and morphology
- Daily Near-Real-Time service possible with development of full automation

Sentinel-1 SAR satellite acquisitions

- Satellite radar acquisitions independent from cloud cover and illumination with a regular acquisition schedule
- Two satellite constellation Sentinel-1 A/B on polar orbit at ~700 km altitude
- Revisit time: 6 days (same orbit); German Bight: Acquisitions almost daily from different orbits

The Sentinel-1 SAR satellite (Image: ESA)

- Interferometric Wide Swath (IW) acquisition mode
  - Swath width: 250 km
  - Image strips of >1000 km length
  - 10 m pixel spacing
- Data available free of charge from Copernicus Data Hub or CODE-DE



Comparison of land-water-lines in the Elbe estuary derived from a Sentinel-1 image from 13.01.2018 with the waterline processor (red) and Cuxhaven LAT level [NHN-2.06 m] in topography survey campaign data from 2010 (blue). The scene was taken at 18:08 when the water level in Cuxhaven was 354 cm, up from 322 cm at 17:18.

DLR's SAR waterline processor

- Supports data from Sentinel-1, TerraSAR-X and other SAR missions
- Contrast-based determination of land-water-boundary
- Developed for tidal flat areas with bright sandbanks and dark mudflats
- Accuracy of about 2 pixels / 20 m in Sentinel-1 IW mode
- Fully automatic operation envisaged
- Output in vector based formats, e.g. kml-polygons
- Combination of multiple scenes with different tidal states allows reconstruction of topography

Possible applications

- Validate and compare modelling results with currently ongoing changes
- Retrieve changes in the past using archive data (available back to 2014) and compare to hindcasting results
- Spot morphologic changes directly without in-situ campaigns to adapt models or inform local authorities
- Identify regions of high variability to focus future measurement campaigns

TriBand antenna at DLR ground station Neustrelitz

Example for one day of Sentinel-1 coverage over German North Sea and Baltic Sea coasts. (Source: CODE-DE)

Satellite data processing chain

- Located at DLR ground station Neustrelitz
- Official receiving and processing station for data from Sentinel-1, TerraSAR-X and many other satellites
- Near Real Time (NRT) processing chain: Automatic generation of value-added maritime products, e.g. wind, sea state, ship detection
- NRT delivery usually within 20 minutes after acquisition
- Data delivery to end user via FTP or quicklook via email, e.g. to ships

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